Potential Applications of Game Theory for DARPA

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Applications of Game Theory:

- Resource Allocation in Computer Networks
- Control Algorithms
- Information Networks
- Information Goods
- Procurement

Resource Allocation in Computer Networks

Challenge:
automated allocation of network resources (e.g. bandwidth, buffer) in time-scales from pre-provisioning through on-line dynamic allocation.

Approach:
use price and demand as the minimal information exchange between application and network.

Goals:
dramatically shorten time to do off-line provisioning, make application QoS possible.

Control Algorithms

Challenge:
design of control algorithms for specific network protocols

Approach:
use differential games to model large number of players

Goals:
formal application of control theory, limited use of bw

Information Networks

Challenge:
decision making -- pooling decentralized information (ad-hoc information networks?)

Approach:
model each information source as a player, and the exchange of information as a link.

Challenge:
war gaming, controlling use of resources against adversaries

Challenge:
national defense as a common good

Challenge:
security systems: coordination within dynamic coalitions

Common Goals:
- design methods for exchange of information
- ad-hoc formation of coalitions
- how to deal with incomplete, probabilistic, decentralized information?
- dynamic issues (stability?)
- interpretation of game theory concepts within this problem
- no exchangeable commodity
- use game theory / pricing to reveal application/user preferences

Information Goods

Challenge:
foster creation of information goods (expensive to produce, cheap/free to reproduce) enabled by networking (e.g. Napster)

Approach:
game theory model to capture common benefit, cost

Goals:
- methods to (en)(dis)courage development of such networks
- new business models for investment, cost recovery
- explore usage of standard protocols (e.g. tcp) versus non-standard alternatives?
- explore use of centralized (newsgroup) vs. peer-to-peer applications

Procurement

Challenge:
procurement, logistics

Approaches:
auction systems, smart markets

Goals:
on-line, decentralized

Common Challenges:

- large # of users, routers
- decentralized
- statistical multiplexing
- uncertainty (measurements)

More Challenges:

- incorporate learning
- computational complexity
- validation/verification
- reduction of models for control purposes